

CYCOM[®] X5320

Innovative Approach to Out-of-Autoclave Processing

September 9, 2008

Report Documentation Page			Form Approved OMB No. 0704-0188		
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1. REPORT DATE SEP 2008		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Innovative Approach to Out-of-Autoclave Processing				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) WPAFB				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Agenda

- Introduction
- Problem Statement
- Cycom X5320
- Potential Value Proposition
- Solicit input on the interest for Out-of Autoclave



Introduction-Cycom X5320 prepreg

CEM is experienced and capable with OOA

- Material Science – through chemistry and understanding
 - Balanced cure cycles to customer requirements
 - Reduce porosity; control viscosity
 - Tack life and total out-time
 - Maximize mechanical properties that drive key design elements
- Technical Service Support – Global tech support of material selection, lay-up, tooling, and assembly
- Application Engineering – PRIM, Automation (AFP, ATL) - BMI & toughened epoxy

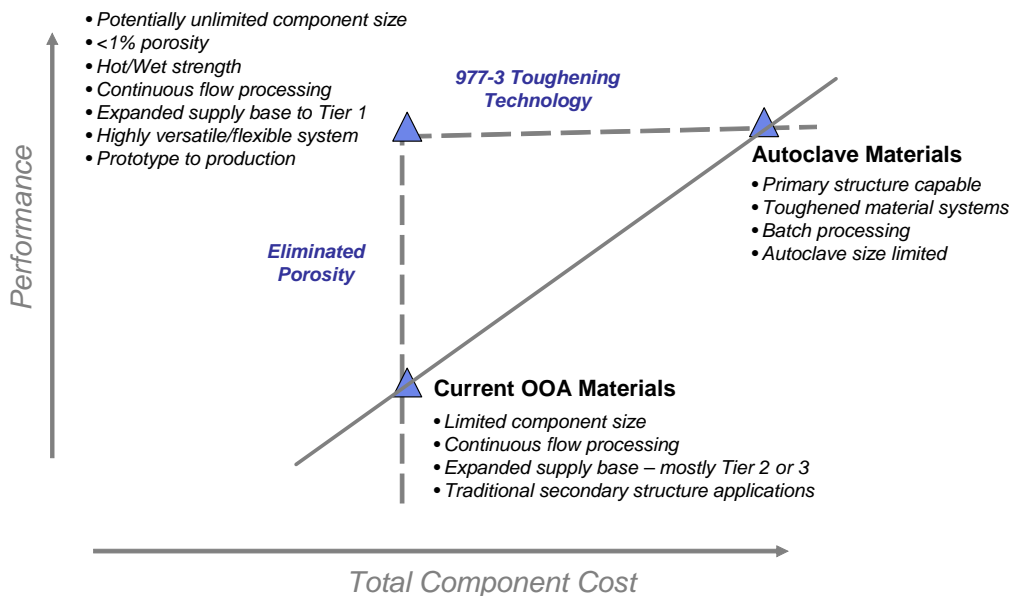
Problem Statement

- Progress technology/capability from secondary to primary structure
- Provide material system capable of prototype or production needs

<u>Gaps Today</u>	<u>Specific Limitation</u>	<u>Target</u>
Mechanical performance	secondary structure	primary
Porosity	<4%	<1%
Tack/Handling	<10 days	30 days
Component size	geometry and dimension limited	unlimited
Versatility	lengthy low temp cure varying properties w/cure poor green strength	<12hr initial consistent excellent

Attacking problem through material science

X5320 - *primary structure performance with OOA benefits*



- Fundamental material science approach
- 977-3 technology
- Critical in-depth understanding of key OOA characteristics of flow, gel, impregnation, resin advancement
- Versatile, robust manufacturing cure cycle options – providing necessary green strength
- Supported by in-application engineering

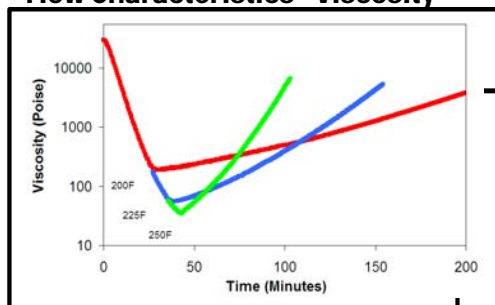
Cycom X5320 Introduction

Breakthrough OOA material – addresses primary structure needs

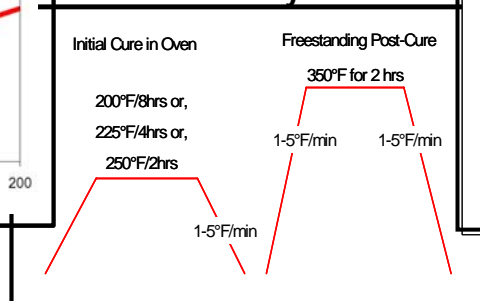
- Legacy military fighter epoxy autoclave mechanical properties with OOA processing
- Large, primary structure component processing
 - Porosity
 - Hot/Wet
- Tailorable handling properties to meet hand-layup and automation part manufacturing
- Prototype parts to high-rate production capable
- Flexible cure cycles providing robust degree of cure with final resin cross-linking

	Current		<u>X5320</u>
	Autoclave	OOA	
Large scale components	✗	✓	☐
Primary structure	✓	✗	☐
Continuous flow process	✗	✓	☐
Hot/Wet strength	✓	✗	☐
Eliminates porosity	✓	✗	☐
Automation	✓	✗	☐

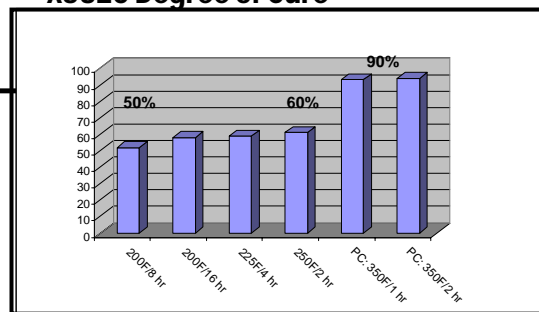
Flow Characteristics - Viscosity



Flexible Cure Cycles



X5320 Degree of Cure



Properties of X5320 limited and preliminary data collection

Properties	977-3 IM fiber	X5320 IM fiber
OHC (220F/Wet) [0/90]3s; ASTM D6484; qty=8	39.3 ksi	42.3 ksi
Tg (Wet) DMA Storage Mod; [0]10	303°F	310°F
OHT (-65F/Dry) [+,0,-,90]3s; ASTM D5766; qty=8	65.4 ksi	75.1 ksi
CAI [+,0,-,90]4s; SRM02R94; qty=8	25.2 ksi	29.6 ksi
Solvent Resistant	Pass	Pass
Initial Cure Temp	355F (autoclave)	200F/16 hours (VBO)

Product Portfolio

Unidirectional Tape

- X5320 T40-800B 145 gsm/33% resin content, 49" width
- X5320 T40-800B 290gsm/33% resin content, 49" width

Fabric

- X5320 WT650-35 3K-8HS 48" width, 36% resin content

Non-Carbon Forms

- X5320 4581Q-9837 38" DP 35% resin content
- X5320 108 50" width, 50% resin content
- X5320 60001 50" width Peel Ply

Ancillary products

Material	Recommended	Target Properties
Film Adhesive	FM300-2K or FM209M	FWT (220F/Wet) Equivalent to FM300 (-65F:800psi, RT:700psi, 250f:500psi)
Foaming Adhesive	FM490A	Similar to FM404A. Passes expansion requirement at 200F of 200%.
Peel Ply	X5320 Peel Ply	Compatible with resin and removes cleanly from part
Syntactic Core	FM381	Density:40 pcf, FWT similar to FM381
Surfacing Film	SM 905M	Clean surface; no surface porosity

Out-of-Autoclave Value Proposition

Performance

- Address porosity and mechanical performance which have historically limited Out-of-Autoclave materials to secondary structures
- Geometrically limited due to part quality of autoclave processing (resin rich, thin out, etc)
- Unitized structure design
- Ability to support rapid, small volume aircraft demonstrations & insertion into production rates

Cost

- Alternative tooling design concepts
- Part count reduction addressing legacy black aluminum designs
- Supply-base capability & expansion
- Lower capital costs for further composite application adoption
- Qualification serves demonstration articles and production

Discussions/Feedback

- Material characteristics
- Material product forms
- Industry Material Specifications – interest, approaches
- Processing constraints, desires
- Database considerations
- Tooling approaches, concerns
- Equipment requirements – ovens, vacuum sources, other heat sources
- Challenging part features for producibility evaluation/scale
- Applications and related constraints/issues
- Variability, robustness
- Further interest?

Please complete the questionnaire provided... your input is essential!